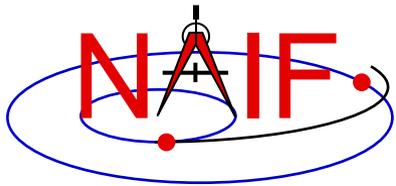




Navigation and Ancillary Information Facility

# Time Conversion and Time Formats

October 2022



# Time Systems and Kernels

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- Time inputs to and outputs from user's programs are usually **strings** representing epochs in these three time systems:
  - Ephemeris Time (**ET**, also referred to as Barycentric Dynamical Time, **TDB**)
  - Coordinated Universal Time (**UTC**). This is the default for calendar strings.
  - Spacecraft Clock (**SCLK**)
- Time stamps in kernel files, and time inputs to and outputs from SPICE routines reading kernel data and computing derived geometry, are double precision **numbers** representing epochs in these two time systems:
  - Numeric Ephemeris Time (TDB), expressed as ephemeris seconds past J2000
    - » J2000 = 2000 Jan 1 12:00:00 TDB
  - Encoded Spacecraft Clock, expressed as clock ticks since the clock start
- **SPICE provides routines to convert between these string and numeric representations.**
- **A time string used as an argument in a SPICE API must be provided in quotes.**
  - Fortran, Matlab, IDL and Python: use single quotes
  - C and JNI: use double quotes



# Converting Time Strings

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- **UTC, TDB, or TDT (TT) String to numeric Ephemeris Time**

- **STR2ET ( *string*, *ET* )**

- » **Converts virtually any time string format known to the SPICE Time subsystem, excepting SCLK.**

- » **Examples of acceptable string inputs:**

'1996-12-18T12:28:28'	'1978/03/12 23:28:59.29'	'Mar 2, 1993 11:18:17.287 p.m. PDT'
'1996-12-18T12:28:28Z'	'1995-008T18:28:12'	'1993-321//12:28:28.287'
'2451515.2981 JD'	'jd 2451700.05 TDB'	
'1988-08-13, 12:29:48 TDB'	'1992 June 13, 12:29:48 TDT'	

- » **Requires the LSK kernel**

These example inputs all use the single quote required by Fortran, IDL MATLAB and Python APIs. Use double quotes for C and JNI APIs.

- **Spacecraft Clock String to numeric Ephemeris Time**

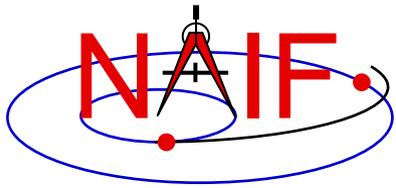
- **SCS2E ( *scid*, *string*, *ET* )**

- » **Converts SCLK strings consistent with SCLK parameters.**

- » **Examples of acceptable clock string inputs:**

- '5/65439:18:513' (VGR1)
- '946814430.172' (MRO)
- '1/0344476949-27365' (MSL)

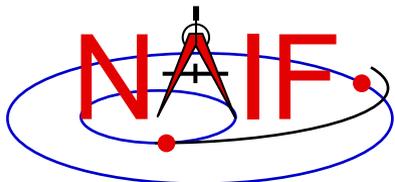
- » **Requires a SCLK kernel and the LSK kernel**



# Converting Numeric Times

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- **Numeric Ephemeris Time to a string, where the format is Calendar, DOY or Julian Date, and the time system is *UTC*, *TDB* or *TDT***
  - **TIMOUT ( *et*, *fmpic*, **STRING** )**
    - » ***fmpic* is an output time string format specification, giving the user great flexibility in setting the appearance of the output time string and the time system used (*UTC*, *TDB*, *TDT*).**
      - See the next slide for examples of format pictures to produce a variety of output time strings
      - See the TIMOUT header for complete format picture syntax
      - The module TPICTR may be useful in constructing a format picture specification from a sample time string
    - » **Requires LSK Kernel**
- **Numeric Ephemeris Time to Spacecraft Clock String**
  - **SCE2S (*scid*, *et*, **SCLKCH** )**
    - » **Requires the LSK and a SCLK kernel**
    - » **Output SCLK string examples:**
      - 1/05812:00:001 (Voyager 1 and 2)**
      - 1/1487147147.203 (Cassini, MRO)**
      - 1/0101519975.65186 (MEX, VEX, Rosetta)**



# Use of Time Format Picture

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## Example Time Strings and the Corresponding Format Pictures

### Common Time Strings

1999-03-21T12:28:29.702

1999-283T12:29:33

1999-01-12, 12:00:01.342 TDB

2450297.19942145 JD TDB

### Format Picture Used (*fmtpic*)

YYYY-MM-DDTHR:MN:SC.###

YYYY-DOYTHR:MN:SC ::RND

YYYY-MM-DD, HR:MN:SC.### ::TDB TDB

JULIAND.##### ::TDB JD TDB

### Less Common Time Strings

465 B.C. Jan 12 03:15:23 p.m.

04:28:55 A.M. June 12, 1982

Thursday November 04, 1999

DEC 31, 15:59:60.12 1998 (PST)

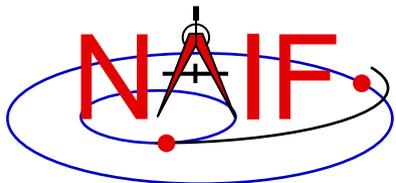
### Format Picture Used (*fmtpic*)

YYYY ERA Mon DD AP:MN:SC ampm

AP:MN:SC AMPM Month DD, YYYY

Weekday Month DD, YYYY

MON DD, HR:MN:SC.## YYYY (PST)::UTC-8

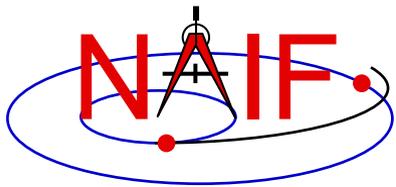


# Additional Time Conversions

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- **Numeric Ephemeris Time to Local Solar Time String**
  - ET2LST( *et*, *body*, *long*, *type*, HR, MN, SC, TIME, AMPM )
    - » Requires SPK (to compute *body* position relative to the Sun) and PCK (to compute *body* rotation) kernels
- **Numeric Ephemeris Time to planetocentric longitude of the Sun (*Ls*)**
  - **LS** = LSPCN (*body*, *et*, *abcorr* )
    - » While *Ls* is not a time system, it is frequently used to determine *body* season for a given epoch
      - LS = 0° , Spring
      - LS = 90° , Summer
      - LS = 180° , Autumn
      - LS = 270° , Winter
  - » The *Ls* calculation requires SPK and PCK kernels

} For the northern hemisphere



# Principal Time System Interfaces

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